

SHUFELDT (R.W.)  
*Osteology of Ceryle alcyon.*

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OSTEOLOGY OF *CERYLE ALCYON*. By R. W. SHUFELDT,  
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Union, &c. (PLATE XIV.)*

REPRESENTATIVES of the family *Alcedinidae* are found pretty generally, though rather unequally, distributed over the continents of the globe. The Australian fauna claims the greatest number of genera and species; to it, however, the genus *Ceryle* is at present still unknown. On the other hand, of the one hundred and twenty or more species recognised as constituting the family, this genus alone, including some half a dozen species, occurs on the American continent. Of these species but two have a place in the ovifauna of the United States, one of which being the subject of this paper, a bird that ranges over nearly all parts of North America during the milder months; the other is the handsome green Cabains' kingfisher, which occurs occasionally in the valley of the Rio Grande, Texas, as a straggler.

Viewed as a whole, the kingfishers form a very curious group of birds; many of its members when compared with each other exhibiting, both in structure and habits, much that is different. As a rule they are birds with rather thick-set robust bodies, short legs, large heads, elegantly crested in some species, straight powerful bills, which are long and sharp-pointed, and these may be of a brilliant coral red colour—as in some of the African and East Indian forms. They make the same impression upon one's mind that the toucans do—that of being top-heavy, appearing as if it might require an effort on their part to keep their balance.

Several of the larger forms known to us are very plainly coloured—possessing only the blacks and whites or the more sombre tints of brown in their plumage. This is not the case, however, with the majority, for many of the smaller species are adorned with the most gorgeous of metallic tints—the blues and greens being the predominant shades.

The toes of their feeble non-ambulatorial feet are arranged upon nearly all the plans as they exist in these members among birds.

In *Ceryle alcyon* the foot is rendered still weaker than it is in many of its relations by nearly complete syndactylism—the middle and outer digits being encased almost to their extremities in a common podothecal sheath.

*Dacelo gigas* has its toes arranged upon the more universal type—that of three in front and one behind; while the tri-dactylous kingfisher of the East Indies has but two in front and one behind. Still others possess zygodactylous feet, agreeing in this respect with the *Bucerotidæ*, a group of birds, in the opinion of many ornithologists, closely akin to the kingfishers.

The typical species of the *Alcedinidæ* resort to the water-courses in the countries where they are found, and live upon small fish, which they secure by plunging into the streams or ponds after them. When successful, the prey is borne in their beaks to some resting place, usually one from which many of their sallies are made, to be devoured. Others live upon reptiles and small mammals, which they capture by pouncing down upon them, much in the same manner as those just alluded to do upon the fish in the streams—the first being really more deserving of the name of “kingfisher.”

Finally, we have those forms which are intimately connected with the *Galbulidæ*, living upon insects, which they commonly take upon the wings.

Nearly all kingfishers are noisy, restless birds; none of them sing; not one of the group as far as I know ever giving vent to anything that might be compared to a song.

Their notes range all the way from the discordant racket, which our present species is so fond of indulging in—to the hyæna-like cry of *Dacelo gigas* as it breaks the stillness of an Australian forest.

Still, I doubt very much that we could find in all England a young naturalist who could suppress his interest and enthusiasm the moment that the favourite little kingfisher of the streams of his land became the topic of conversation; much less would the older devotees of the science, who perchance have adopted other countries for their homes, part with their recollections of the azure-

tinted little sprite that haunted the river banks, where their days were spent in boyhood, during many a fishing and collecting excursion. It is just so with our New England naturalists; our memory-picture of the great broad stream at home, with its noisy mill and its drooping willows, would be incomplete without its kingfisher, and the rattle of his note has made an impression upon our ear never to be forgotten. We must believe that the thoughts of the veteran Wallace reflected homewards to the sunny banks of the Thames, when, far away in Amboyna, he first collected the racquet-tailed kingfisher. In his charming book, *The Malay Archipelago*, which I have twice read with pleasure, he tells us, relating the instance, that "these birds differ from all other kingfishers (which have usually short tails) by having the two middle tail-feathers immensely lengthened, and very narrowly webbed, but terminated by a spoon-shaped enlargement, as in the motmots and some of the humming-birds. They belong to that division of the family termed king-hunters, living chiefly on insects and small land-molluscs, which they dart down upon and pick up from the ground, just as a kingfisher picks a fish out of the water. They are confined to a very limited area, comprising the Moluccas, New Guinea, and Northern Australia. About ten species of these birds are now known, all much resembling each other, but yet sufficiently distinguishable in every locality. The Amboynese species, of which a very accurate representation is here given, is one of the largest and handsomest. It is full seventeen inches long to the tips of the tail-feathers; the bill is coral red, the under surface pure white, the back and wings deep purple, while the shoulders, head, and nape, and some spots on the upper part of the back and wings, are pure azure blue. The tail is white, with the feathers narrowly blue-edged, but the narrow part of the long feathers is rich blue. This was an entirely new species, and has been well named after an ocean goddess by Mr R. G. Gray."

From all that is known of the internal and external structure of the *Alcedinidae*, authors are pretty well agreed upon the taxonomic position the family holds with respect to other groups of birds.

Systematic ornithologists still adhere to that "polymorphic group" known as picarian birds,—the order *Picariae*. This

order—a very unnatural one, and the necessity for its existence only going to prove our lack of knowledge of the structure of the majority of the forms that have been huddled together in it—is usually considered as being divisible into three sub-orders.

These sub-orders are (1) the Cypseli, including the three families *Cypselidæ*, *Caprimulgidæ*, and *Trochilidæ*; the (2) Cuculi, which include some sixteen or seventeen families, our *Alcedinidæ* being one of them, and the most important of the others being the *Cuculidæ*, the *Bucconidæ*, the *Galbulidæ*, the *Meropidæ*, and the *Trogonidæ*. The third sub-order is the *Pici*, into which fall the woodpeckers and wrynecks, and the family *Picumnidæ*.

This arrangement is seen to be somewhat different in Huxley's classification, based upon the structure of the palatal bones, and now familiar to all of us. Here, this author says of the *Desmognathæ*, his third sub-order of birds, that "not fewer than seven groups of families appear to me to be clearly distinguishable in this sub-order—viz., the *Chenomorphæ*, the *Amphimorphæ*, the *Pelargomorphæ*, the *Dysporomorphæ*, the *Aetomorphæ*, the *Psittacomorphæ*, and the *Coccygomorphæ*. In addition to these undoubted *Desmognathæ*, I shall at the end of this series consider the woodpeckers under the name of *Celeomorphæ*."<sup>1</sup>

It is only those forms which this able taxonomist includes in his *Coccygomorphæ* that interest us at present. *This group is characterised in the following manner:—*

#### "7. COCCYGOMORPHÆ.

"The rostrum presents very various forms, and may be movably articulated with the skull. Basipterygoid processes are present only in one genus (*Trogon*).

"The maxillo-palatines are usually more or less spongy. The palatines are not developed into vertical plates, but are, as usual, horizontally flattened.

"The distal end of the quadrate bone has the ordinary form.

"The sternum usually presents two notches on each side, and has no bifurcated manubrial process (ex. *Merops*).

<sup>1</sup> "On the Classification of Birds," &c., *Proc. Zool. Soc.*, April 11, 1867, p. 460.

"The clavicles are convex forwards, and without any process developed backwards from the summit of their symphysis.

"The tarso-metatarsus is never remarkably elongated.

"It does not appear that anything can be predicated in common of the pterylosis or of the characters of the oil-gland in this group.

"The larynx has not more than one, or at most two, pair of intrinsic muscles.

"The *Coccygomorphæ* are readily divisible into four groups by the characters of their feet, as follows:—

"A. *The first toe turned forwards, as well as the others.*

*Coliidae.*

"B. *The fourth toe temporarily, or permanently, turned backwards, as well as the first.*

*Musophagidae.*

*Rhamphastidae.*

*Cuculidae.*

*Capitonidae.*

*Buceonidae.*

*Galbulidae.*

"C. *The second, third, and fourth toes turned forwards; the first backwards.*

*Alcedinidae.*

*Meropidae.*

*Bucerotidae.*

*Momotidae.*

*Upupidae.*

*Coracidae.*

"D. *The first and second toes permanently turned backwards; the third and fourth forwards.*

*Trogonidae.*

"This group, as I have already intimated, appears to occupy the centre of the Desmognathous division—the *Musophagidae* approaching the *Aetomorphæ*, the *Trogonidae* the *Cypselomorphæ*, and the *Alcedinidae* the *Pelargomorphæ*."<sup>1</sup>

In two genera of kingfishers—*Alcyon* and *Ceyx*—but three toes occur on each foot, abortion of the second digit having taken place in the feet of the species comprising them.

As little is known of the anatomical structure of the group,

<sup>1</sup> "On the Classification of Birds," &c., *Proc. Zool. Soc.*, April 11, 1867, p. 466-67.

I was encouraged in the hope, that adding the description of the skeleton of so important a representative as the Belted Kingfisher to the literature of the subject, would prove of interest and perhaps value. Upon the drawings in Plate XIV. I have bestowed great pains, and they may be at least relied upon as accurate. Mr Alfred Newton tells us with great truth that "it is to be regretted that hitherto no light has been shed by palæontologists on this interesting subject, for the only fossil referred to the neighbourhood of the family is the *Halcyorius toliapicus* of Professor Owen (*Br. Foss. Mamm. and Birds*, p. 554), from the Eocene of Sheppy—the very specimen said to have been previously placed by König (*Icon. foss. Sectiles*, fig. 153) in the genus *Larus*." <sup>1</sup>

Touching then, as I have in the foregoing paragraphs, in as brief and comprehensive a manner as possible, and yet as fully as such an essay as this demands, upon the general characteristics of kingfishers,—their distribution, their mode of life, and the views of the leading authorities upon their toxonomy, we will now proceed to a study of the skeleton, and commence this with an examination.

*Of the Skull.*—Not having a young kingfisher at hand, it will be impossible to define with absolute certainty the sutures among the various bones of the skull of this bird. In a great many cases they have been completely obliterated; but as it is my intention to confine my observations in this paper to the adult skeleton, rather than to its development, this is not of so much consequence. We have every reason to believe, however, that the skull has been formed by the union of the usual bones found in ordinary birds' heads, though one has resulted, which in many respects is very different from the more common pattern, and presenting points of interest peculiarly its own. By consulting the three first figures of Plate XIV., it will be seen that the upper mandible has the form of a three-sided pyramid, with a broad base and sharp-pointed apex. The base seems to rest upon the remainder of the skull, and the bones of the same appear to stop abruptly as they reach it. In its plane above we see a strongly-marked fronto-maxillary suture (fig. 2); while nearly in a vertical line beneath we notice the apparent sudden

<sup>1</sup> *Ency. Brit.*, 9th ed., p. 82, art. "Kingfisher.

termination of the palatines and maxillaries (Plate XIV. fig. 3). The actual base of this pyramid is formed by the great spongy maxillo-palatines, which here bound the rhinal chamber anteriorly, being pierced above only by the cylindrical nasal tubes which lead to the external nostrils. These latter are elliptical in outline, with their major axes parallel with the long axis of the pyramid, being separated from each other by a solid bony septum narium, and situated, as we see them in fig. 2 of Plate XIV., on the flat sides of the mandible.

In *Alcedo ispida* the septum narium is pierced by an oval foramen, at about its centre. Just to the rear of their posterior border in *Ceryle*, on either side, there is to be found a small circular foramen leading into the nasal passages already mentioned, that course the maxillo-palatines (fig. 2, *nf*). These foramina are absent in *Alcedo*.

The culmen, which forms one angle of this mandibular pyramid, is rounded; the tomium, or those edges which correspond to them in the skull, are quite sharp, and slightly raised above the remaining side, which they bound. This side, constituting as it does the roof of the anterior portion of the mouth, is an unbroken, smooth, horizontal surface; its median and longitudinal line being marked by a distinct groove, which becomes broader behind, to merge into the maxillo-palatines, between the latter bones (Plate XIV. fig. 3).

We find this mandible in *Ceryle*, although having a very solid appearance from being closed in on all sides as it is, to be extremely light, having internally very much the same structure as in the hornbills, only rather coarser.

There is one other feature we notice on the superior aspect of the mandible in *Alcedo* that is absent in *Ceryle*; this is a pretty well marked groove, leading on either side from the anterior margin of the nostril back to the maxillary. It is shown in the drawing of this view of the skull here presented, from a specimen kindly lent me by Mr F. A. Lucas of the United States National Museum (*k*, fig. 1, *b*). Regarding the skull of our kingfisher from above, we find the superior margins of the orbits sharp and regular, and separated from each other by the smooth, rather broad surface of the frontal region. This is slightly indented longitudinally by a shallow median groove that tra-

verses the cranium from the fronto-maxillary line, through the parietal portion. Here the surface is raised, on either side, into smooth rounded domes, that are bounded behind by the prominent and projecting temporal fossæ. These latter are divided behind by a sharp median ridge (Plate XIV. fig. 2). All these features, though present in *Alcedo*, are far less noticeable, while the median ridge tends to merge into the surrounding surfaces. This is completely effected in the skull of *Geococcyx*, where the temporal fossæ are well separated, and the median ridge has become a broad surface, indistinguishable from the general

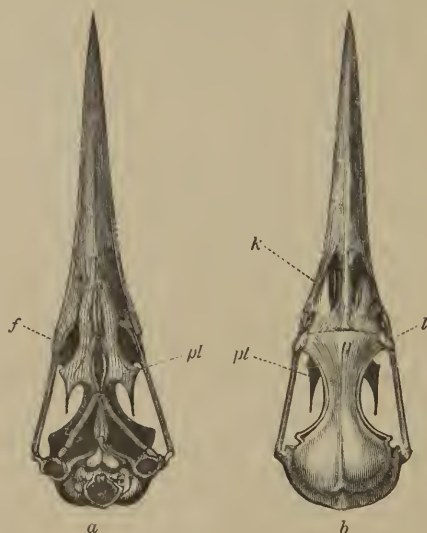


FIG. 1.—Superior (*b*) and inferior (*a*) views of the skull of *Alcedo ispida*. *l*, lacrymal; *pl*, palatine; *k*, inter-naso-maxillary groove on the mandible; and *f*, the maxillary. Life size from nature.

superficies of the cranial vault. Holding a mid position between these two conditions, we find an example in the skull of *Coccyzus americanus*, where the fossæ approach each other again. If we suppose a perpendicular to be let fall through the skull to a point just a little beyond the condyle, it is observed that the plane of the occipital surface makes an angle with this line of about 15°. It is gently undulating in character, the foramen magnum being found in its lower third. The usual nervous and

vascular foramina are seen on either side of this, and rather deep sinus canals above. Its superior margin in *Ceryle* is very sharp, while in *Alcedo* and *Geococcyx*, where this surface has the same general character, this boundary is more rounded.

Viewing the skull laterally (Plate XIV. fig. 1), the unusually deep temporal fossa is again brought to our notice, occupying much of the space behind, terminating only at the superior margin of the ear cavity, and allowing but just enough surface for the lodgment of the head of the quadrate. It has above it a flattened squamosal process, which is separated by a shallow concavity, still more anteriorly, from a feebly pronounced post-frontal projection. The ali-sphenoidal wall bulges forward in the form of an elevated dome, a feature characteristic also of *Alcedo*. Above, the thin and horizontal frontal affords the orbit an ample roof, this bone being carried forward to join with the extension surface of the superior portion of the large lacrymal.

If we look at a lacrymal from above (Plate XIV. fig. 2, *l*), it presents an oblong surface with slightly rounded angles. Its inner margin articulates closely with the nasal anteriorly and the frontal behind, about one-third being devoted to the former and the remaining two-thirds to the latter bone. There is thrown down from beneath this superior oblong plate of the lacrymal, the connection being a somewhat constricted neck, another plate, which forms the greater part of the anterior wall of the orbit. This plate has a smooth surface with a light, spongy interior; its shape is square, with rounded angles. Its outer portion below rests upon the horizontally expanded maxillary, while its inner and upper angle has wedged into it a small oblong process that is developed from the ethmoid. The two close in above a large elliptical foramen, through which, in life, the nasal nerve and vessels pass. This inferior plate of the lacrymal is nearly double the size of the superior, and is placed at right angles to it.

In *Alcedo ispida*, the arrangement for the lacrymal which we have here given is substantially the same. It differs principally in being thicker from before backwards, and the process from the ethmoid, which in this kingfisher is triangular, meets it about the middle of the inner border rather than the superior and inner angle, as it does in *Ceryle*. In *Geococcyx*, the superior plate has

moved down on the margin of the orbit nearer the maxillary, articulating almost exclusively with the nasal. This change nearly does away with any distinction between an inferior and superior plate, the two having run together in nearly the same plane.

The ethmoid here develops a very large wing-like plate, and the lacrymal is so twisted to pass down in front of it, the former really forming the anterior wall of the orbit. In *Coccyzus americanus*, the ethmoidal wing is very extensive, and forms the entire inter-orbito-rhinal partition, while the lacrymal barely articulates with it, it being a light little bone, having very much the form we find in *Oryzæ*.

One large vacuity is found in the interorbital septum in *Ceryle alcyon*, as shown in Plate XIV. fig. 1. This has the appearance of being divided in two by a very narrow isthmus of bone above in *Alcedo*, but we find this deception due to the large foramina for the exit of the nasal nerves from the brain case in this bird, these openings being exceedingly small in *Ceryle*.

The quadrate presents little or nothing that is peculiar. Its orbital process is sharp and spine-like, projecting into the orbital space, though overshadowed by the bulging wall of the alisphenoid above. This process of the quadrate is remarkably stumpy and short in *Alcedo*, while it is broad and flat in *Geococcyx* and *Coccyzus*, where it almost rests against the posterior wall of the orbit.

Upon the inferior view of the skull of *Ceryle*, we observe the anterior extremities of the palatines to be broad, horizontally flattened and thin plates. They are separated from each other by an interval of about 2 mm., and merge beyond into the bony roof of the mouth already alluded to. The interval between their anterior ends is continued backwards to a point well within the articulation of the heads that articulate with the pterygoids. Near their inner margins, posteriorly, quite a large foramen exists in each, though I cannot say it is a constant character, opposite the anterior projection of the ethmoid. Each palatine throws up a triangular plate of bone to project freely into the rhinal space. The outer and posterior angles of these bones are truncate, the right hand in my specimen being notched (Plate XIV. fig. 3).

Referring to the cut of the inferior view of the skull of

*Alcedo* accompanying this paper, we observe that these angles are produced backwards into long needle-like processes.

This is characteristic also of *Dacelo gigantea*,<sup>1</sup> while "in *Merops* the long and slender palatines are devoid of any postero-external elongations."<sup>2</sup>

In my specimens of *Coccyzus americanus* there are no such processes present, but the angles are distinctly defined, differing in this respect from *Cuculus canorus*, where "the palatines are rounded off postero-externally" (Huxley). This is the case also in the skulls I have at hand of *Geococcyx*, but Professor Huxley found them to be distinctly indicated in the specimens he examined of this bird, so here this character may vary perhaps with the age of the individual.

I find no vomer in *Ceryle alcyon*, and in this it agrees with others of the group, for we know "in kingfishers and hoopoes there is no vomer."<sup>3</sup>

In our kingfisher the pterygoids are very long and straight, their distal extremities having on their outer sides little horizontally flattened and projecting triangular processes, an absent feature in *Alcedo*, *Geococcyx*, and *Coccyzus*. None of the forms just mentioned possess basi-ptyergoid processes, and the pterygoids in the ground cuckoo are very short in comparison with the great length of the skull, being somewhat shorter than they are in *Alcedo*.

In *Ceryle* the maxillaries are broad, horizontally expanded plates (Plate XIV. fig. 3), passing into the extensively developed maxillo-palatine masses, anteriorly, which nearly fill up the forward part of the rhinal chamber. In *Alcedo* this expansion is not particularly noticeable, while in other respects the arrangement of these parts is the same.

These two kingfishers differ from each other in the manner the quadrato-jugal bar articulates with the quadrate. In *Ceryle* it is received into an articulating socket on the outer side of this bone, while in *Alcedo* it meets it much more anteriorly, though somewhat laterally.

<sup>1</sup> Huxley, "Classification of Birds," &c., *Proc. Zool. Soc.*, April 11, 1867, p. 447, fig. 29.

<sup>2</sup> Huxley, "Classification of Birds," &c., *Proc. Zool. Soc.*, April 11, 1867, p. 448.

<sup>3</sup> Parker, *Morphology of the Skull*, p. 264.

The form of the lower mandible is well shown in Plate XIV. figs. 1 and 3. It does not essentially differ in *Alcedo ispida*. Both of these birds have the ramal vacuity spanned across with a thin plate of bone, which may be pierced by a minute foramen. Among the cuckoos this bone is very much more like the general form as we find it in the Passerine types.

In *Coccyzus* a large ramal vacuity exists, and the internal angular processes are long and pointed, curving upwards, while rudimentary posterior angular processes here commence to make their appearance.

Nothing worthy of particular note rewards our examination of the internal aspect of the brain case. The usual sclerotal plates are present in the eyes, and proportionate in size with the other parts. Arrangement of the ear-cell is very simple; the delicate bony tie beams found in its interior in so many birds is here replaced by solid bone, pierced only by the necessary openings.

The hyoid apparatus (fig. 7) departs very markedly from ordinary birds. This is seen principally in the broad first basi-branchial (*bh*), with its slender, connate second basi-branchial (*bbh*) reduced in this bird to a mere spine of no great length. The epi-branchials are very much shortened, and extremely delicate in structure, being tipped behind as usual with cartilage. Behind the glossohyal (*gh*) is broad and quadrilateral in outline, the cerato-hyals being scarcely discernible at its posterior and outer angles.

*Of the Axial Skeleton.*—The vertebræ of *Ceryle*, when compared with many other birds of about the same size, are large in comparison, with prominent processes. We find nothing to particularly distinguish the atlas. The plate closing in the neural canal of this segment above is oblong in outline, with a minute spine at each outer and posterior angle. The body is thick from before backwards, so the shallow cup for the occipital condyle is never perforate, as it is in many birds. A large neural spine is found on the axis, and the diapophyses are elevated. Situated somewhat posteriorly, a neural spine, smaller than that of the axis, is found on the third vertebra, and this process diminishes in size as we proceed backwards, to disappear entirely on the ninth vertebra. The twelfth has a small one again, becomes larger still in the thirteenth, and in the next

of the series appears very much like the elevated quadrate plates as seen in the dorsals. In the third vertebra the foramen found in the plate between the pre- and post-zygapophyses, as a common avian characteristic, is here scarcely perceptible. But in this vertebra two other features arise—the cervical extremity of the vertebral canal, with minute parapophyses projecting from it on either side, and the appearance of an hypapophysis beneath. The vertebral canal persists through the cervical chain to include the twelfth vertebra; in the thirteenth it is closed in by a very delicate little rib, consisting of but scarcely anything more than head, neck, and tubercle. In the fourth vertebra the hypapophysis is but feebly developed, while the parapophyses are much stronger; these latter disappear in the twelfth vertebra. The carotid canal marks the inferior surfaces of the centre of the fifth to the ninth vertebræ inclusive; while in the tenth, eleventh, and twelfth a median single plate reproduces the hypapophysis once more. This process is three-pronged in the thirteenth, bifurcate, with nearly horizontal limbs, in the fourteenth, which decrease in size in the next, still to persist in the first and second dorsal, to become a single plate again in the third dorsal, and disappear altogether or be quite rudimentary in the fourth or last dorsal vertebra. The fourteenth cervical bears a pair of good-sized free ribs, but they are without unciform processes. These appendages appear, however, on the next pair, which are also free, being suspended from the fifteenth or last cervical vertebra. So there are three ultimate segments in this division of the column that support each a pair of free ribs. The four dorsal vertebræ, with their ribs connecting with the sternum, have nothing very peculiar to mark them. They freely articulate with each other, and develop stumpy metapophyses on their transverse processes. The unciform projections are not ankylosed with the ribs. Two pairs of ribs are suspended from beneath the ilia, belonging to the antecedent vertebræ of the so-called “sacrum.” The first pair have small unciform processes, their hæmapophyses articulating with these bones on the last dorsals in the usual manner; the last pair, which are very delicate in structure, vary exceedingly in length, and terminate in free extremities.

For convenience sake, we will describe the compound bone

composed of the next twelve anchylosed vertebræ, with the ossa innominata, as the pelvis (Plate XIV. fig 8). In our kingfisher it is quite narrow anteriorly, with shallow and open ilio-neural canals, divided by the common sub-compressed neural spine. This soon merges into the broad and smooth surface that forms the greater part of the superior aspect of this bone, being quite devoid of any particular points for examination beyond a few foramina as we near the caudal end.

We note on the outer iliac margins, on either side, a sharp triangular process, directed backwards, that is quite characteristic of *Ceryle*. The caudal vertebræ are seven in number, including the pygostyle. They have wide extending transverse processes (Plate XIV. fig. 8), the last three and the coccygeal vomer developing bifurcate hypapophyses below.

The *sternum* of *Ceryle alcyon* is rather a curiously-formed bone, and quite differently shaped from the sterna of ordinary birds (Plate XIV. figs. 10 and 11). At its hinder extremity it is four-notched, with the outer pair of xiphoidal processes dilated at their extremities. This dilatation is observable, though not to such a marked degree in the inner pair. Four facets for the hæmapophyses of the dorsal ribs are found on the superior aspect of each costal border, and beyond the anterior ones prominent costal processes arise. The keel protrudes far beyond the body of the bone, its upper and anterior angle being rounded off, the opposite condition being the case in the inferior one. The grooves for the coracoids do not meet in the median plane by a millimetre or two, and a deep pit is found on the superior surface of the protruding keel, mesiad, between the inner and lower angles of these bones. Complete abortion of the manubrium has taken place; not a vestige of such a process can be seen. Indeed, the coracoidal facets are the most projecting parts of the sternal body. A single circular pneumatic foramen, which is constant, is found on the superior aspect of the body in the middle line, where it terminates anteriorly.

With respect to the bones of the *shoulder girdle* (Plate XIV. fig. 9) we find a scapula to be quite broad, of nearly uniform width throughout, being obliquely truncate at its posterior end. The coracoid is considerably dilated at its sternal end, with raised facet on its posterior aspect for the sternal articulation. The

clavicular limbs are very broad above, and much compressed from side to side, being reduced to thin blade-like bones; their scapular heads reach far backwards, and afford quite an articular surface for these bones. No hypocleidium exists at their mesial union, but the lower part of this U-shaped arch is curved upwards and backwards. In the articulated skeleton (Army Medical Museum, Washington, Section Comparative Anatomy, No. 155) it rests against the anterior border of the sternal keel at the junction of the middle and lower third.

*Of the Appendicular Skeleton.*—In the pectoral limb the humerus is the only bone possessed of pneumaticity. Proportionately it is very long—being but  $\frac{2}{3}$ ths shorter than the bones of the antibrachium. Its radial crest is but moderately developed, but in other respects this bone presents the usual characters found among birds generally. The osseous tubercles for the quill-butts of the secondaries, found in many of the class along the shaft of the ulna, are here absent or very faintly perceptible in some specimens. Both bones of the antibrachium in the well-developed limit of this kingfisher are as we usually find them in ordinary birds. The two carpal segments are well apart from each other, thus affording quite an extensive share of the head of the metacarpus for articular surface for radius and ulna.

One phalanx is allotted to pollex digit, two to index, and one to medius, claws and spurs being absent in the manus of *Ceryle*.

The pelvic limb is entirely non-pneumatic, and is interesting principally in the evident feebleness of the foot (Plate XIV. figs. 5 and 6). In the *femur* the shaft is straight and cylindrical, being unmarked by ridges or lines for muscular attachment. An ordinary avian *patella* is present. On the proximal and anterior aspect of the tibia the pro- and ecto-cnemial ridges are but feebly produced, and the leg-bones lend their share to the general weakness of this extremity, or really, more correctly speaking, when referring to this part of it, its small size in comparison with the rest of the skeleton. The *fibula* has but a slender spine of bone below the fibular ridge of its companion with which it articulates, and in some specimens I find even this missing. When this latter condition exists, *Ceryle* has as short a fibula as any bird with which I am at present acquainted.

The *tarso-metatarsus* is less than a third as long as the shaft of the tibia (Plate XIV. fig. 6, *mt'*.); the free metatarsal for hallux thus being obliged to take a position in articulation very near the middle of the shaft of this bone. The "hypotarsus" is large in proportion, and exhibits but a single longitudinal groove posteriorly for the passage of the tendons. The digits of the foot possess the normal number of phalanges, as they occur in the class. They have the usual form and proportionate lengths, but careful examination of the opposed surfaces of the bones composing the outer and middle toes show the effect of their being so long strapped together in a common podathecæal sheath, in the evident compression of the ridges and elevations usually found on these phalangeal bones in feet where the digits are free.

#### DESCRIPTION OF PLATE XIV.

Fig. 1. Right lateral view of the skull and lower mandible of *Ceryle alcyon*, life size; *l*, lacrymal; *nf*, nasal foramen; *ns*, nasal septum; *q*, quadrate; *pg*, pterygoid; *pl*, palatine; *m*, maxillary.

Fig. 2. Superior view of skull of *Ceryle alcyon*, lower mandible removed, life size, letters as in figure 1.

Fig. 3. Basal view of skull of *Ceryle alcyon*, lower mandible removed, life size, letters as before, with *s*, sinus canal; *fm*, foramen magnum.

Fig. 4. Superior view of lower mandible of *Ceryle alcyon*, life size.

Fig. 5. Left pelvic limb of *Ceryle alcyon*, life size; *F*, femur; *P*, patella; *Fb*, fibula; *T*, tibia; *j*, hallucal metatarsal; *h*, phalanx of hallux; *mt*, tarso-metatarsus.

Fig. 6. The tarso-metatarsus, *mt*, in front view, life size, from same limb.

Fig. 7. The hyobranchial apparatus of *Ceryle alcyon*, viewed from above, life size; *gh*, glosso-hyal; *ch*, cerato-hyal; *bh*, first basi-branchial; *bbh*, second basi-branchial; *c.br*, cerato-branchial; *e.br*, epi-branchial.

Fig. 8. Superior view of pelvis, coccygeal vertebræ and pygostyle *in situ*, of *Ceryle alcyon*, life size.

Fig. 9. Left lateral view of shoulder girdle of *Ceryle alcyon*; bones bearing proper relation to each other, life size; *S*, scapula; *C*, coracoid; *Cl*, clavicle.

Fig. 10. Lower view of sternum of *Ceryle alcyon*, life size, and shows very well how far the keel in the curiously shaped sternum of this bird projects beyond the body of the bone.

Fig. 11. Left lateral view of sternum of *Ceryle alcyon*, life size; *o*, the usual site of the manubrium, which is absent in this bird.

